REPORT NUMBER: WI/FEP-10-03

EVALUATION OF THE CONSTRUCTABILITY & PERFORMANCE OF MICRO-SILICA MODIFIED CONCRETE BRIDGE DECK OVERLAYS

FINAL REPORT

WISCONSIN TECHNOLOGY ADVANCEMENT DEPARTMENT OF TRANSPORTATION

December 2003

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16. Abstract

The effects of construction practices and material properties on the performance of concrete bridge deck overlays are evaluated in this study. Emphasis is placed on evaluating the constructability and performance of the micro-silica modified concrete bridge deck overlay and determining if the modified micro-silica overlays are performing at a level that justifies the extra cost and construction precautions. Two continuous concrete hunched slab bridges were included in the study. Field surveys were conducted to document cracking patterns and rapid chloride permeability (RCPT) analysis. Construction data was collected from construction documents, field books, and weather data logs.

The study demonstrates that crack numbers and density increased with age for bridge decks with modified micro silica overlays. Site conditions play a big role in the application and the rate of evaporation of water on the concrete surface. The delamination and total defects have increased after ten years.

17. Key Words	18. Distribution Statement
Micro-Silica, Concrete Overlay, Permeability, Modified Concrete, Longitudinal & Horizontal Cracking, Pozzolan, Delamination, Debonding. Bridge decks	Approved for public release

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Evaluation of the Constructibility & Performance of Micro-Silica Modified Concrete Bridge Deck Overlays

WisDOT Research Study # WI-89-01

FINAL REPORT
Report # WI/FEP-10-03

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For

WISCONSIN DEPARTMENT OF TRANSPORTATION
DIVISION OF TRANSPORTATION INFRASTRUCTURE DEVELOPMENT
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December 2003

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INTRODUCTION

The use of micro-silica as a pozzolan in concrete was originated in Scandinavia during the early 1950's and was introduced to the United States in 1984. Micro-silica is a by-product from the silicon carbide and metallic industries where it is recovered from exhausts of electric furnaces. It is approximately a hundred times finer than Portland cement. When it is used in concrete, it acts as a filler and as a cementitious material. The small silica fume particles fill spaces between cement particles and between the cement past matrix and aggregate particles. The silica fume also combines with calcium hydroxide to form additional calcium hydrate through the pozzolanic reaction. Both of these actions result in a denser, stronger and less permeable material.

WisDOT initiated a research study in 1989 to evaluate the application and performance of latex modified and micro-silica modified concrete overlay on bridge decks. Both types of concrete overlays have the characteristics of a high compressive strength and very low permeability to chloride intrusion; thus, reducing the rate of steel bar corrosion. These characteristics should lead to more durable and protective concrete overlays.

The work plan for this study was modified during the construction of the project. The focus of the study was only on the application and performance of the micro-silica. The latex was eliminated from this study because of the high cost and the negative feedback that was received from DOT and the contractor personnel. The participant in the construction phase of this project (DOT & contractor personnel) stated that the latex was hard to work with, because it set quickly and formed a ¼-inch crust on top. Workers also complained that the mix was sticky and it was very difficult to trowel or finish.

PROJECT SITE & LOCATION

The two structures included in this study are located on STH 50 between I-94 and 43rd Avenue in Kenosha County, Wisconsin. Micro-silica modified concrete overlays were placed on Structures B-30-35, East Bound and B-30-36, West Bound *(See Figure1 in Appendix A, page 16).*

OBJECTIVES

The objectives of this study were to evaluate the application and performance of micro-silica modified concrete. The study was conducted over a five-year period with respect to:

- CONSTRUCTIBILITY
- PERFORMANCE
  - Visual Inspection of Cracking
  - Thermographic Infrared Survey
  - Concrete Permeability
  - Compressive Strength
  - Delamination
- COSTS

CONSTRUCTIBILITY

In order to familiarize the concrete producer, contractor, and Wisconsin DOT personnel with the product, the project special provisions required technical assistance from the micro-silica supplier (W.R. Grace & Co. of Chicago) for proper mix proportions, placement, finishing, and curing of the micro silica modified concrete. The contractor chose the option of concrete production at a local batch plant. Prior to concrete placement, all the decks were scarified, unsound concrete was removed, and the surfaces were given a final cleaning. On the evening before resurfacing, the decks were sprayed with water and covered with polyethylene. Excess deck water was removed by air blasting prior to applying the bonding grout, before the latex and micro-silica modified concrete placement.

A test slab of the micro-silica was poured at the producer's site allowing a chance to discover deficiencies prior to actual placement. Information regarding mix design, placement and test data is attached to this report (S*ee Appendix B*). The overlay was placed at a minimum thickness of 1-1/2 inches. The concrete was distributed using a finishing machine with a screw-type auger and roller, followed by a vibrating pad. Wet burlap was placed immediately following the surface finishing operation. Temperatures were ideal during placement, ranging from 65° F to 75° F. The amount of micro-silica was about 7-1/2 percent by weight of cement or 50 pounds of dry solid per cubic yard.

According to WisDOT observers and contractor workers, the concrete was very workable and set up well in a reasonable amount of time. However, micro-silica modified concrete could not be poured if the ambient temperature was above 80 degrees, because it is not very workable beyond this temperature.

PERFORMANCE

Visual Inspections

The two bridges were originally constructed in 1962 and overlaid in 1989. Visual inspections of both bridges were conducted in 1990, 1991, 1995, 1997, and 2001.

B-30-35 (Micro Silica):

Type: Continuous Concrete Haunch Slab.

Spans: It consists of three spans, 31', 40', and 31', total length of 102'.

Width: 29.7' – two lanes.

B-30-36 (Micro Silica):

Type: Continuous Concrete Haunch Slab.

Span: It consists of three spans, 31', 40', and 31', totaling 102' in length.

Width: 29.7'- two lanes.

Site Evaluation 1990 & 1991 (B-30-35&36)

Site performance evaluations during 1990 & 1991, indicated that the micro-silica modified concrete overlays were intact and both overlays were performing very well. Some minor longitudinal cracking was observed at the transverse sawcut joints of both structures. Some of this may have been initiated by shrinkage cracking.

Debonding was not readily apparent or detectable by hammer or chain drag sounding. Some debonding was suspected at the deck boundaries. This was confirmed by a thermographic infrared inspection survey (using a infrared machine that detects delamination, spalling, debonding and other defects in the pavement) in 1990 (*see table 1, on page 6*). The total area of debonding of the overlay was 19 square feet, out of 6,120 square feet for the two structures. This represents 0.31% of the total area surveyed. The locations of the debonded areas of the overlay are at the deck boundaries at the abutment of the structures.

Site Evaluation (1995) B-30-35

The underside of the deck was in good condition. Several minor longitudinal cracks in the central and east spans near the center of the bridge as well as one small longitudinal crack in the west span of the bridge. The wearing surface had several spalls and patches at the joints, near the east and west abutment. Several fine longitudinal cracks, approximately one to two feet in length, were present at the construction joints.

Site evaluation (1997) B-30-35

The underside and the wearing surface of the deck showed little change in condition since the last inspection in 1995. However, delamination had increase drastically since the last inspection in 1995.

Site Evaluation (2001) B-30-35

The underside of the deck showed several full depth longitudinal and horizontal cracks scattered throughout the bottom of the deck. Delamination was also present along some of these cracks. The wearing surface had longitudinal and horizontal cracks (random) throughout the bridge deck, ranging in length between two to ten feet. The density and lengths of the cracks had increased since the last inspection. As shown in Table 1, the total defective area had increased drastically since the 1997 inspection and increased even more since the 1999 therographic infrared inspection.

Site Evaluation (1995) B-30-36

The underside of the deck was in good condition. Minor longitudinal cracks were present in the haunch areas near the center of the bridge. The wearing surface exhibited several fine longitudinal cracks at the construction joints, ranging between 1 and 2 feet in length.

Site Evaluation (1997) B-30-36

In general, there was little change since the last visual inspection in 1995 (*See Table 1*). The underside of the deck was in good condition. Minor longitudinal cracks were present in the haunch areas near the center of the bridge. The wearing surface showed several longitudinal cracks at the construction joints, which were one to two feet in length.

Site Evaluation (2001) B-30-36

The underside of the deck showed several full depth longitudinal and transverse cracks; delamination was also present along some of these cracks. The wearing surface had longitudinal and transverse cracks (random) throughout the bridge deck, ranging in length between two and ten feet. The density and lengths of the wearing surface cracks had increased since 1997 inspection as shown in Table 1. As shown in Table 1 the total defective area had increased drastically since the 1997 inspection and nearly doubled since the 1999 inspection.

Thermographic Infrared Surveys

Infrared surveys of both bridges were conducted in 1990, 1995, 1997, 1999, and 2001.

Survey (1990)

The results showed that both structures had minor defects during the first year of service, after the application of the micro-silica overlay *(See Table 1 & Appendix D).*

Survey (1995)

The results in 1995 showed that the total defects had increased approximately five times between 1990 and 1995 for both Structures *(See Table 1 & Appendix D).*

Survey (1997)

There was minimal difference in total defects for B-30-35 from the 1995 inspection. The total defect for B-30-36 was doubled from 1995, but was still minimal.

Survey (1999)

The total defects for both structures had increased substantially over the two-year period, since the 1997 survey. The total defects for B-30-35 had increased from 2.9 percent to 16.4 percent and from 2 percent to 11.8 percent for B-30-36 (*See Table 1, & Appendix D*).

Survey (2001)

The total defects for B-30-35 had increased from 16.4 percent to 17-20 percent, while for B-30-36 the total defects had increased substantially from 11.8 percent to 20-25 percent (*See Table 1 & Appendix D).*

Therographic Infrared Inspection Results

	TOTAL DEFECTS % (Delamination, Debonding, Concrete Patching, AsphalticPatching, Spalling)				
STRUCTURE	1990	1995	1997	1999	2001
B-30-35	0.4	2.4	2.9	16.4	17-20
B-30-36	0.2	1.0	2.0	11.8	20-25

Table 1

Delamination

Delamination surveys were done on both structures using Infrared Thermographic in 1990, 1995, 1997, 1999, and 2001. The surveys revealed that in the first seven years both structures performed very well. Delamination was only 2% for both structures, seven years after the application of the overlay in 1989. However, between 1997 and 1999, delamination increased almost seven times from the previous results in 1997. Between 1999 and 2001, the delamination roughly doubled and reached 25% for B-30-35 and 20 % for B-30-36 (*See Table 4, Appendix C for more details & Appendix D for Supporting Documents).*

<u>Concrete Permeability</u>

Based on other states' experiences and their recommendations, the amount of micro-silica was reduced from 10 to 7-1/2 percent by weight of the cement or 50 pounds of dry solids per cubic yard. Reportedly, the lower percentage of micro silica with superplastizer would provide adequate impermeability with less shrinkage cracking.

In 1989, the W.R. Grace Co Cambridge Lab and Wis DOT Materials Lab conducted rapid chloride permeability tests in accordance with AASHTO T 277-83. For the concrete with micro silica, eleven readings were taken averaging 564 coulombs, ranging from a low of 287 to a high of 864 coulombs (S*ee Table 2*). These values are very acceptable and within the 100 to 1000 coulombs range for very low concrete permeability to chlorides. The results of the testing are shown below:

Permeability Test Results

W.R. Grace Co. Lab Results (September/14/1989)	
Structure ID.	**Coulombs Passed**
B-30-35	864
B-30-36	713
B-30-36	734
Wisconsin DOT Material Laboratory Results (August 7, 1989 pour).	
Structure ID.	**Coulombs Passed**
B-30-35	525
B-30-35	628
B-30-35	387
B-30-35	828
B-30-36	287
B-30-36	374
B-30-36	407
B-30-36	456

Table 2

Picture of deck showing some cracking (B-30-35)

Picture of bridge deck crack (B-30-35)

Picture of the bottom of structure (B-30-35) showing crack and efflorescence

Random cracks throughout the bridge wearing surface (B-30-36)

Cracks & spalling in the wearing surface (B-30-36)

Cracks & efflorescence in the bottom of the deck (B-30-36)

Compressive Strength

The City of Milwaukee Testing Laboratory performed the compressive strength testing. Cylinders were field cured for 48 hours and then placed in a lime saturated water tank for the remainder of the curing duration. Compressive cylinder strengths at 28 days ranged from 7,000 to 8,000 psi (See Table 3, below). It appears that future cement content can be reduced from 660 pounds to 600 pounds per cubic yard. The micro-silica supplier is in agreement with this reduction

Compressive Strength Test Results

East Bound Deck (B-30-35)		West Bound Deck (B-30-36)	
Age/Days	P.S.I.	Age/Days	P.S.I.
3	5210	3	5720
7	6100	7	7210
14	6750	14	7470
14	6750	14	7950
28	6890	28	8450
28	7170	28	8180

Table 3

COSTS

The cost of the micro-silica modified concrete overlay was approximately 2-1/2 times more expensive than the conventional concrete mix, averaging $320 per cubic yard. The cost of the conventional concrete was approximately $130.

CONCLUSIONS

1. The test slab helped understand some of the problems and fix them prior to actual application of the overlay.
2. Permeability tests showed low coulomb readings for both bridges with the micro-silica overlay. This was interpreted to mean that the concrete has a higher resistance to chloride penetration than conventional concrete mix.
3. At the time of concrete placement, the micro-silica mix is very sensitive to temperature, humidity, and wind speed. Some of these factors play a role in the rate of evaporation of water on the concrete surface. For micro-silica overlays, crack densities increase as the temperature ranges increase; and, crack densities decrease as relative humidity increases.
4. The use of prewetting and burlap to cover the overlay helped reduce the rate of water evaporation; thus, decreased the shrinkage cracks.
5. The delamination and total defects of the micro-silica bridge decks had increased drastically after 10 years. The total defects increased from 0.4 to 17-20 % for B-30-35 and from 0.2 to 20-25% for B-30-36 (between 1990 & 2001).
6. The number and length of cracks increased after 10 years.
7. Micro-Silica mix behaved the same as a conventional mix during placement.
8. The cost of Micro-Silica mix was approximately 2.5 times the cost of a conventional mix.
9. Literature indicates that recent studies conducted by others had better success using a new improved formula of the micro-silica. The studies emphasized the importance of using proper curing methods, allowing sufficient curing time, and proper percentages of the micro-silica added to the mix.

RECOMMENDATIONS

1. If you are going to use micro-silica, keep in mind that it only has an effective performance life of 5 to 10 years.
2. When using micro-silica in the specifications always require technical assistance from the micro-silica supplier.
3. Consider other alternatives, since the cost of the micro-silica product is approximately 2.5 times the conventional concrete mix.
4. Cracks may have to be sealed 2 to 3 years after application and continue maintenance work for the life of the overlay.
5. Specify a maximum of 50 pounds of micro-silica per cubic yard and reduce cement content to a maximum of 600 pounds per cubic yard.
6. Require a test slab prior to actual placement to make any adjustment prior to the actual deck overlay.
7. Prewet the deck surface the day prior to concrete overlay placement; blast off excess water prior to placing the bonding grout.
8. In future studies have a control section for comparison, using conventional concrete mix.
9. Postpone placement if the temperature exceeds 80 degrees Fahrenheit.
10. Watch humidity, air velocity and other site condition that may influence the evaporation rate.
11. Immediately upon completing surface finishing, apply burlap and use continuous water cure for three days and wet cure with burlap for a minimum of seven days.
12. Check for debonding immediately after placement and patch if necessary.

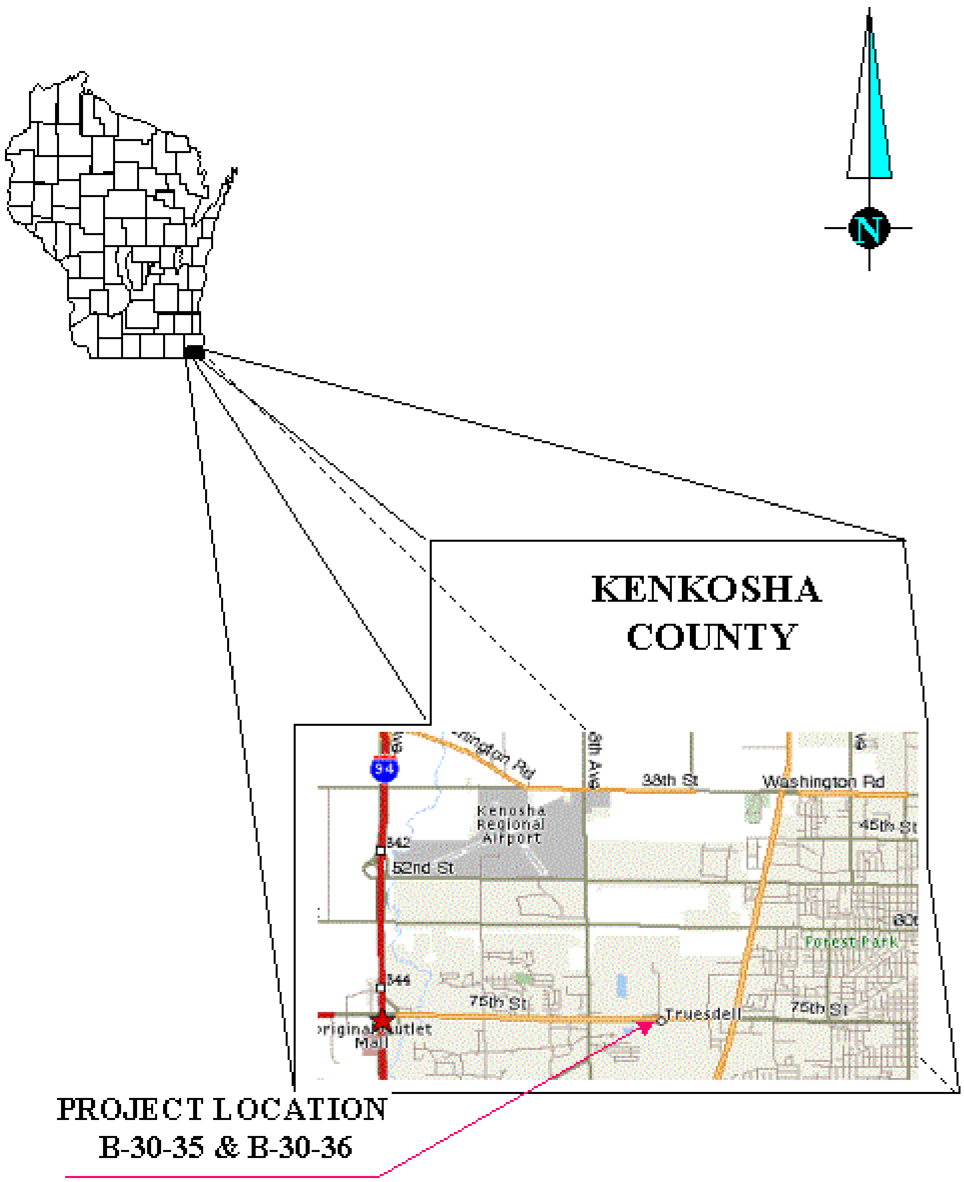
Studies Done By Others

Several research studies were done by other states and other researchers on the use of latex and micro-silica modified concrete in bridge deck overlays. The followings are some of their conclusions and recommendations.

1. The crack density for bridges with micro-silica overlay has increased with increased age of the overlay.
2. Lower diffusion coefficients, indicating slower diffusion of chloride or a higher resistance to chloride penetration, therefore better performance.
3. The age range between 500 to 1500 days (1.4 – 4.1 years) includes both micro-silica and conventional overlays; overall, the silica overlays do not appear to provide significantly higher resistance to chloride penetration and may perform worse than conventional overlays.
4. The crack density for a cement content 640 1b/C.Y. is nearly four times greater than that for cement contents of 602-605 1b/C.Y.
5. For micro silica overlays, the level of cracking increases as the number of load cycle increases. However, conventional overlays, show no clear trend between the number of load cycles and the level of cracking, although for load cycles greater than 2.5x10^6 the level of cracking increases as the number of load cycles increases.
6. For micro silica overlays, use of both fogging and procure material during and after finishing decrease the crack density.
7. The crack density for bridges with latex and micro-silica overlay has increased with increased age of the overlay.
8. A low coulomb reading for all bridges with latex and micro-silica overlay. This was interpreted to mean that the concrete has a higher resistance to chloride penetration.
9. Site conditions at the time of concrete placement, such as air temperature (low or high air temp.), daily temperature, wind velocity, relative humidity. Some of these factors play role in the rate of evaporation of water on the concrete surface. For micro silica overlays, crack density increases as the temperature range increases. Cracks density decrease as relative humidity increases.

APPENDIX A

**FIGURE 1. MICRO-SILICA INSTALLATION SITE
COLUMBIA & DANE COUNTY**



APPENDIX B

ATTACHMENT-1

Comment on the Mix Design, Placement, and Test data for Micro-Silica Modified Concrete.

Contractor: Zenith Tech Inc.; Waukesha, WI.

READY MIX SUPPLIER: Kencrete Inc.; Chicago IL

MICROSILICA SUPPLIER: W.R. Grace & Co.; Chicago, IL
Technical Assistant: Ron Brown

MIX DESIGN PARAMETERS: The following are the design criteria set forth by the State DOT:

1. Type 1 Portland Cement 660 1bs.
2. Micro-silica 50 1bs.
3. Total Fine and Coarse Aggregate 2960 1bs.
4. Coarse Aggregate to be No. 1 Stone
5. A Type G, H.R.W.R. or a combination of a Type F, H. R. W.R. and a Type D, Retarder shall be used.
6. Maximum slump: 7”
7. Maximum w/c ratio: 0.40
8. Air Content: 6% _+ 1.5%

PROJECT MIX DESIGN: The following one-yard weights are S.S.D.:

Type 1 Cement (Lonestar Greencastle)	660	1bs.
Microsilica (Force 10,000 D)	50	1bs.
No. 1 Stone	1760	1bs.
Fine Aggregate	1200	1bs.
Total Water	265	1bs.
Air Entraining Agent (Daravair R)	7.5	oz/yd
H.R.W.R. (Daracem 100)	73-92	oz/yd

BONDING GROUT: Mixture of 3 parts Type 1 Cement, 1-part Microsilica solids and adequate water to make the mixture slurry.

TEST DATA: Concrete slump, air content, concrete and ambient temperatures were taken on the test slab pour. The test pour was done to give the contractor a chance to practice placing, finishing, fogging and curing the Microsilica concrete. Cylinders were taken from the test pour. The test pour was used to fine-tune the addition rates of our A.E.A. and H.R.W.R.

<u>Hardened Air</u>

A linear Traverse was run on one of the 4" x 8" cylinders from the East Bound Deck. This test was performed on 9/15/1989.

Air Content (%)	6.55	6.6
Ave. Chord (IN)	0.0036	
Spec. Surface (1/IN)	1117.7	
Spacing Factor (IN)	0.0038 *	

The Spacing Factor has been based on a calculated paste content of 28.11%.

- A.C.I. 201 "Guide to Durable Concrete" states that the Spacing Factor should be less than 0.0080.

Cambridge lab in accordance with AASHTO T-277-83I ran the rapid chloride permeability tests with results as follows:

APPENDIX C

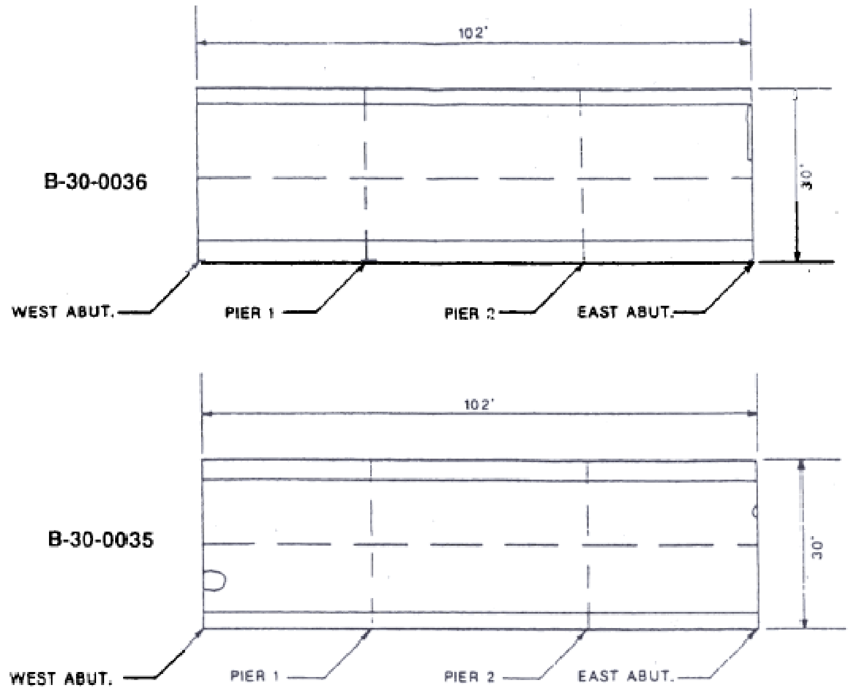
INFRARED INSPECTION RESULTS

	Structure Number	YEAR INSPECTED 1990	1995	1997	1999	2001
Total Area (Sq.Ft.)	B-30-35	3060	3060	3060	3060	3060
	B-30-36	3060	3060	3060	3060	3060
Area Inspected (Sq.Ft.)	B-30-35	3060	3060	3060	3060	3060
	B-30-36	3060	3060	3060	3060	3060
Delamination (Sq.Ft.) (%)	B-30-35	0 0	62 2	62 2	464 15.2	765 25
	B-30-36	0 0	31 1	62 2	350 11.4	610 20
Debonding (Sq.Ft.) (%)	B-30-35	12 0.4	0 0	0 0	0 0	0 0
	B-30-36	7 0.2	0 0	0 0	0 0	0 0
Asphaltic Patch (Sq.Ft.) (%)	B-30-35	0 0	0 0	0 0	0 0	0 0
	B-30-36	0 0	0 0	0 0	0 0	0 0
Concrete Patch (Sq.Ft.) (%)	B-30-35	0 0	10 0.3	28 0.9	37 1.2	65 2.1
	B-30-36	0 0	0 0	0 0	11 0.4	40 1.3
Spalled (Sq.Ft.) (%)	B-30-35	0 0	10 0.3	28 0.9	37 1.2	65 2.1
	B-30-36	0 0	0 0	0 0	11 0.4	40 1.3
Total Defects (Sq.Ft.) (%)	B-30-35	12 0.4	82 2.6	118 3.8	538 17.60	895 29.2
	B-30-36	7 0.2	31 1	62 2	372 12.20	690 21.6

Table 4

APPENDIX D

Supporting Document



S.T.H. 50 OVER TOWN ROAD

LEGEND

- Delamination
- Debond
- Spalled
- Asphalt Patch
- Concrete Patch
- Area In Shade

	ST. NO. B-30-0035		ST. NO. B-30-0036	
DESCRIPTION	QUANTITY (SQ.FT.)	%	QUANTITY (SQ.FT.)	%
TOTAL AREA	3060		3060	
SHADE/DEBRIS	0		0	
TOTAL AREA INSPECTED	3060		3060	
DELAMINATION	0	0	0	0
SPALL	0	0	0	0
DEBOND	12	0.4	7	0.2
ASPHALT PATCH	0	0	0	0
CONCRETE PATCH	0	0	0	0
TOTAL DEFECTS	12	0.4	7	0.2

INSPECTION DATE: 5/90

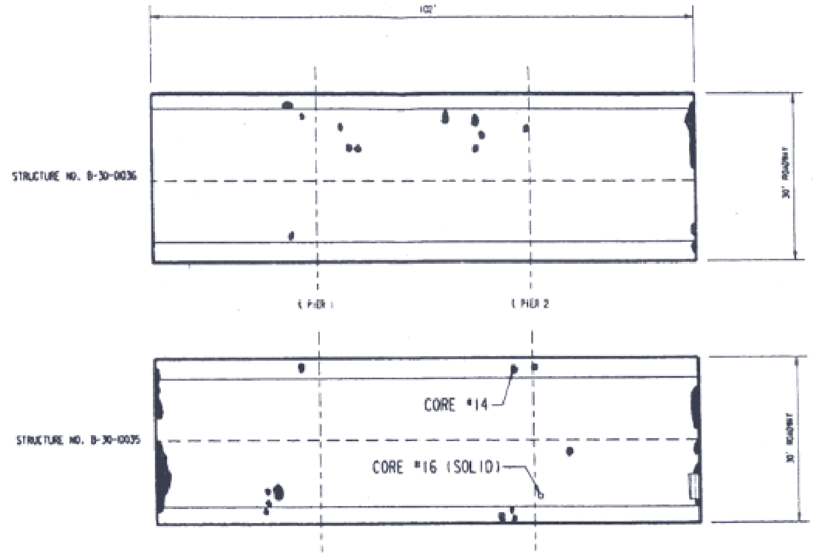
SCALE

0' 5' 10' 20'

STRUCTURE NOS. B-30-0035 & B-30-0036

NAMES	DATE		
INSPECTED	5/90	INFRARED THERMOGRAPHIC INSPECTION OF S.T.H. 50 OVER TOWN ROAD WISCONSIN DEPARTMENT OF TRANSPORTATION	RUST ENVIRONMENT & INFRASTRUCTURE
CADD			PROJECT NUMBER
CHECKED DU			DATE

INSPECTION DATE: 6/1990



S.T.H. 50 OVER TOWN ROAD

	ST. NO. B-30-0035		ST. NO. B-30-0036	
DESCRIPTION	QUANTITY (SQ.FT.)	%	QUANTITY (SQ.FT.)	%
TOTAL AREA	3060		3060	
SHADE/DEBRIS	0		0	
TOTAL AREA INSPECTED	3060		3060	
DELAMINATION	63	2.1	31	1.0
SPALL	0	0	0	0
DEBOND	0	0	0	0
ASPHALT PATCH	0	0	0	0
CONCRETE PATCH	10	0.3	0	0
TOTAL DEFECTS	73	2.4	31	1.0

INSPECTION DATE: 6/95

SURFACE TYPE: MICRO SILICA CONCRETE OVERLAY - 1989

LEGEND

- DELAMINATION
- SPALL
- DEBOND
- ASPHALT PATCH
- CONCRETE PATCH
- SHADE/DEBRIS

SCALE 0' 5' 10' 20'

STRUCTURE NOS. B-30-0035 & B-30-0036

NAMES		DATE
INSPECTED:	TC/DS	6/95
ANALYZED:	TC	7/95
CADD:	DS	9/95
CHECKED:	DU	10/95
APP'D:		
APP'D:		
APP'D:		

INFRARED THERMOGRAPHIC INSPECTION OF S.T.H. 50 OVER TOWN ROAD WISCONSIN DEPARTMENT OF TRANSPORTATION

DISTRICT 2

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NUMBER 74421.020 DATE 12/21/95

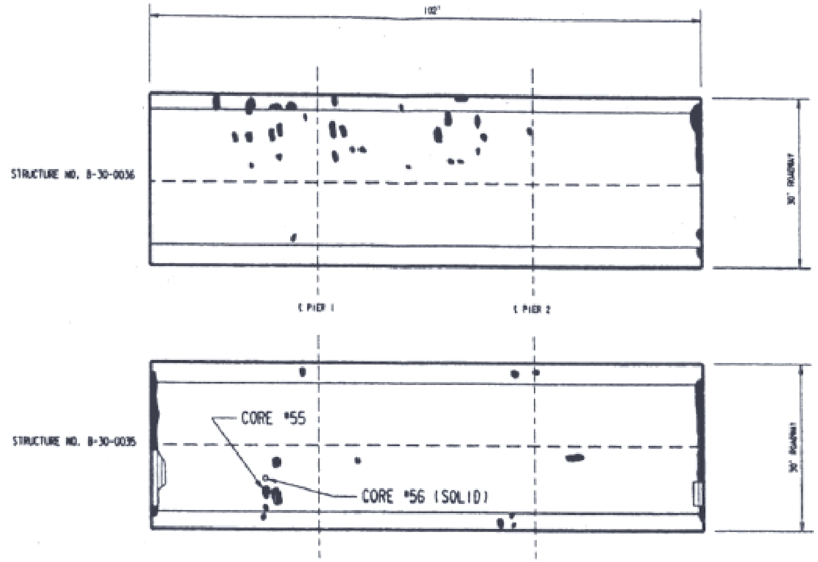
RUST DWG NUMBER

FILE NAME 30-35-95.DGN

CLIENT DWG NUMBER

SHEET NUMBER

INSPECTION DATE: 6/1995



LEGEND
DELAMINATION
SPALL
DEBOND
ASPHALT PATCH
CONCRETE PATCH
SHADE/DEBRIS

S.T.H. 50 OVER TOWN ROAD

	ST. NO. B-30-0035		ST. NO. B-30-0036	
DESCRIPTION	QUANTITY (SQ.FT.)	%	QUANTITY (SQ.FT.)	%
TOTAL AREA	3060		3060	
SHADE/DEBRIS	0		0	
TOTAL AREA INSPECTED	3060		3060	
DELAMINATION	62	2.0	62	2.0
SPALL	0	0	0	0
DEBOND	0	0	0	0
ASPHALT PATCH	0	0	0	0
CONCRETE PATCH	28	0.9	0	0
TOTAL DEFECTS	90	2.9	62	2.0

INSPECTION DATE: 4/97

SURFACE TYPE: MICRO SILICA CONCRETE OVERLAY - 1989

SCALE

0' 5' 10' 20'

STRUCTURE NOS. B-30-0035 & B-30-0036

NAMES		DATE
INSPECTED:	JG	4/97
ANALYZED:	TC	8/97
CADD:	DS	8/97
CHECKED:	DV	8/97
APP'D:		
APP'D:		
APP'D:		

INFRARED THERMOGRAPHIC INSPECTION OF
S.T.H. 50 OVER TOWN ROAD
WISCONSIN DEPARTMENT OF TRANSPORTATION

DISTRICT 2

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NUMBER 74421 DATE 8/28/97

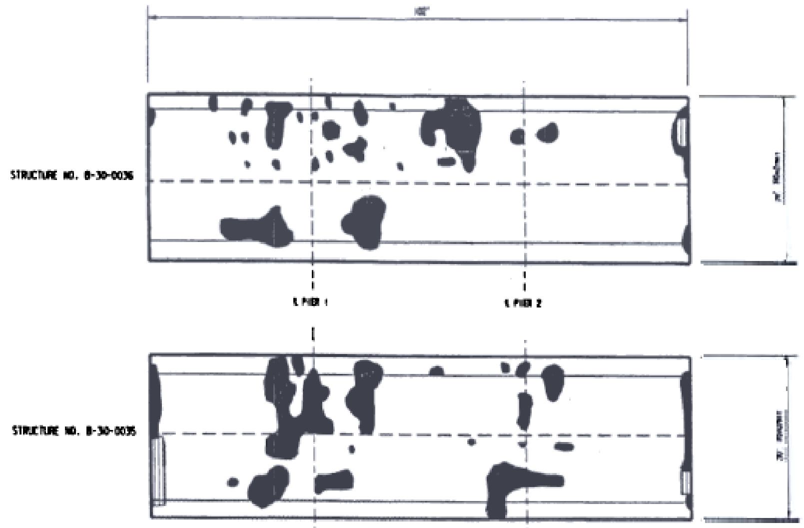
RUST DWG NUMBER

FILE NAME 30-35-97.DGN

CLIENT DWG

SHEET NUMBER

INSPECTION DATE: 6/1997



LEGEND

- DELAMINATION
- SPALL
- DEBOND
- ASPHALT PATCH
- CONCRETE PATCH
- SHADE/DEBRIS

S.T.H. 50 OVER TOWN ROAD

	ST. NO. B-30-0035		ST. NO. B-30-0036	
DESCRIPTION	QUANTITY (SQ.FT.)	%	QUANTITY (SQ.FT.)	%
TOTAL AREA	3060		3060	
SHADE/DEBRIS	0		0	
TOTAL AREA INSPECTED	3060		3060	
DELAMINATION	464	15.2	350	11.4
SPALL	0	0	0	0
DEBOND	0	0	0	0
ASPHALT PATCH	0	0	0	0
CONCRETE PATCH	37	1.2	11	0.4
TOTAL DEFECTS	501	16.4	361	11.8

INSPECTION DATE: 6/99

SURFACE TYPE: MICRO SILICA CONCRETE OVERLAY - 1989

SCALE

0' 5' 10' 20'

STRUCTURE NOS. B-30-0035 & B-30-0036

NAMES		DATE
INSPECTED:	TC	6/99
ANALYZED:	TC	8/99
CADD:	LDS	9/99
CHECKED:	DU	9/99
APP'D:		
APP'D:		

INFRARED THERMOGRAPHIC INSPECTION OF
S.T.H. 50 OVER TOWN ROAD
WISCONSIN DEPARTMENT OF TRANSPORTATION

DISTRICT 2

RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NUMBER 104130 DATE 9/99

RUST DWG NUMBER

FILE NAME 30-35-99.DGN

CLIENT DWG NUMBER

SHEET NUMBER

INSPECTION DATE: 6/1999

References

1. Wisconsin DOT Standard Specification for Road and Bridge Construction 1989 Edition.
2. Update on Ohio DOT's Experience With Concrete Containing Silica-Fume, By Dennis Bunke, December 1989.
3. Performance And constructability of Silica-Fume Bridge deck Overlays. Kansas DOT, By Gerald Miller & David Darwin-University of Kansas. January 2000